Central bank balance sheet and inflation in a euroised small open economy: a cointegrated SVAR analysis

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Abstract

The Bank of Albania has not employed traditional balance sheet policies; however, it has taken a series of policy actions that have increased the proportion of non-borrowed relative to borrowed components of the monetary base and its balance sheet liabilities. We aim to investigate whether these changes in the structure of the central bank balance sheet gave rise to additional monetary shocks with direct effects on inflation. The hypothesis is tested by estimating a small structural VAR model with cointegrated I(1) and I(0) policy and non-policy variables. We identify long-run restrictions based on the embedded structure of the data generating process, as defined by cointegration relationships. Our findings suggest that an increase in the share of non-borrowed components of the monetary base has direct and indirect positive effects on inflation. We argue that the identification of this monetary shock has significant implications for the central bank and its monetary policy.

Keywords: monetary policy, structural VAR, cointegration, permanent monetary injections, central bank balance sheet

1 INTRODUCTION

For most of the past two decades, monetary authorities around the world were mainly concerned with low inflation and below-target inflation expectations resulting from negative and persistent shocks such as the Great Financial Crisis (GFC) and the Covid pandemic. To support the economy and bring inflation back to target after the onset of such shocks, central banks in advanced economies first lowered policy interest rates to close to (or even below) zero, and then, as a new policy tool, started expanding their balance sheet.

Unlike central banks in advanced economies, central banks in small, open and highly euroised emerging market economies such as Albania had limited options in terms of policy instruments, financial markets, or indeed the motivation to apply such balance sheet policies.[1] Nevertheless, in its effort to achieve the inflation objective and preserve financial stability, the Bank of Albania (BoA) undertook a series of policy actions aimed at increasing the level of international reserves, reducing the extent of euroisation, and containing the negative effects of exchange rate shocks on inflation. These actions provided additional liquidity to the banking system outside the traditional framework of monetary operations. They also changed the structure of the monetary base and of BoA liabilities in favour of non-borrowed or permanent funds.[2] The main hypothesis of this paper is that increasing the share of non-borrowed components of BoA balance sheet liabilities via permanent monetary injections had the effect of an additional monetary shock, above and beyond the expansionary effects of policy rate cuts.[3]

[1] See Sejko (2021) for a detailed discussion of how implementation of balance sheet policies is constrained by shallow, underdeveloped financial and capital markets and the lack of tradable securities.

[2] The literature typically refers to permanent vs. non-permanent monetary injections. In this paper we use the terms non-borrowed and permanent injections interchangeably, in the sense that permanent funds comprise currency in circulation plus all bank reserves that are not borrowed from the central bank.

[3] For the purpose of this paper monetary shocks are referred to as balance sheet structural shocks. The early literature on the topic that emerged in the late 1990s referred to monetary base rather than balance sheet shocks.

The discussion on non-borrowed versus borrowed monetary injections has been framed in the literature mainly in terms of permanent versus temporary monetary injections in advanced economies (Krugman, Dominquez and Rogoff, 1998; Bernanke, 1999; Eggertson and Woodford, 2003; and Svensson, 2003). One finding of this literature is that increases in the monetary base via permanent injections have positive effects on prices and aggregate demand, the reason being that, if these injections had been perceived as temporary, no such effects would have materialised. Bernanke and Mihov (1998) discuss a similar topic in terms of borrowed vs. non-borrowed bank reserves. There are no studies that explore this topic in the context of emerging market economies in central and south-eastern Europe. Our research aims to fill this gap by investigating whether changes in the structure of central bank balance sheet liabilities in favour of non-borrowed (permanent) funds impar additional monetary shocks with direct or indirect effects on inflation. We also contribute to the literature in terms of empirical methodology, by applying a recent structural vector error correction model (SVECM) to the identification method of Oularis, Pagan and Restrepo (2018).

Our results indicate that an increase in the share of non-borrowed funds in the monetary base acts as a separate monetary shock with direct and indirect positive effects on inflation. The direct effect is small. The indirect effect is stronger and works through the exchange rate channel. This suggests that the BoA can use increases in the share of non-borrowed funds as a monetary policy tool when the effectiveness of policy interest rates is constrained.

We test our hypothesis by estimating a small structural vector autoregressive (VAR) model with policy and non-policy variables. The latter include CPI inflation, GDP as a measure of economic activity, M3 as a measure of demand for money, and the lek-euro exchange rate as a multidimensional macro-financial variable with an important role in the Albanian economy. The main policy variable is the monetary policy interest rate. In line with Krugman, Dominquez and Rogoff (1998), Bernanke and Mihov (1998), and Eggertson and Woodford (2003), we introduce as the second policy variable a balance sheet structure indicator, defined as the ratio of non-borrowed monetary base to total monetary base, both in domestic currency. This indicator serves as a proxy for permanent as opposed to temporary liquidity injections. To achieve proper identification, we also use foreign prices in the model.

The identification of structural shocks in our VAR is guided by two insights. First, identification of the structural VAR (SVAR) is based on Oularis, Pagan and Restrepo (2018), who use cointegration relationships to identify long-run restrictions. This method has the advantage of using existing characteristics embodied in the data generating process – the order of integration of the variables and/or existence of potential cointegration relationships – rather than authors' beliefs on long-run relationships to identify long-run restrictions. We also rely on our knowledge of the policymaking process, described in detail in the BoA's annual and quarterly monetary policy reports, to decide the order and interaction of shocks in the model.

The rest of the paper is structured as follows. Section 2 briefly describes the Bank of Albania monetary policy framework. Section 3 discusses our empirical framework and data. Section 4 presents and discusses our estimates. Section 5 summarises the findings and discusses some policy implications.

2 BANK OF ALBANIA MONETARY POLICY FRAMEWORK

The Albanian economy is a small, open, emerging market economy with a high level of euroisation in real and financial sectors, and underdeveloped capital and financial markets.[4] The euro area is Albania's main trade and financial partner, and real and financial shocks originating in it have significant spillovers on the domestic economy. In addition, developments in global energy and commodity markets strongly influence Albania's inflation.

Price stability is the BoA's primary objective. To fulfil this obligation mandated by law, the BoA relies on an inflation targeting framework, a free-floating exchange rate regime, and liberalised external current and capital accounts. The main monetary policy instrument is the repo rate, the interest rate on weekly repurchase agreements. Through repo or reverse repo open market operations and overnight deposit and lending facilities, the BoA aims to keep interbank and money market rates close to the policy rate, and at the same time ensure that the liquidity needs of the financial system are met. An important consideration is that monetary policy in Albania is implemented in an environment of a structural deficit of liquidity in the money market.

Like other central banks, during 2008-22 the BoA was mainly concerned with low inflation and inflation expectations falling below target. Following the GFC and the euro area sovereign debt crisis, it thus embarked on a prolonged period of expansionary policy, lowering interest rates from 6.25% in 2010 to 1% in June 2018, and further to 0.5% in March 2020 at the outbreak of the Covid pandemic. Throughout this period, inflation was stable but below its long-term target of 3%. It jumped above the target only in autumn 2021, under pressure from surging import prices.

A related concern for the BoA was the relatively weak transmission of its interest rate changes to economic activity and prices. This was largely a structural issue, reflecting the high euroisation of the real economy and the financial sector and exchange rate developments – a strong depreciation in the aftermath of the GFC, followed by sharp appreciation. These developments raised financial stability concerns: a large fraction of private sector borrowings and deposits – around 75% and 50% of the total, respectively – were already in euros. Depreciation and shrinking economic activity after the GFC first led to a sharp increase in private sector non-performing loans (NPLs), which reached their peak at 25% of total loans in 2015, significantly damaging private and banking sector balance sheets.

[4] In the second half of 2022, foreign currency loans represented 51% of total loans and foreign currency deposits 46% of total deposits in the Albanian banking system (BoA, 2023).

The subsequent appreciation of the lek against the euro, as well as excess liquidity and low interest rates in the euro area at the time, encouraged foreign currency borrowing, especially by the public sector. After the second eurobond issue in November 2015 (valued at €450 million), the Ministry of Finance strategically shifted the refinancing of maturing, mostly lek-denominated, debt from domestic to foreign sources (BoA, 2015: 58). This resulted in 4 more eurobond issues reaching a total of €3.15 billion by end-2023. The share of eurobonds in total foreign debt thus increased from 13% in 2015 to nearly 40% in 2023.[5]

By the mid-2010s, it also became clear that the lek appreciation was one of the main forces behind low inflation. Bahmani, Miteza and Tanku (2020) showed, for example, that money demand did not react symmetrically to exchange rate developments: domestic currency balances would shrink when the lek weakened, but would not increase when the lek strengthened against the euro.

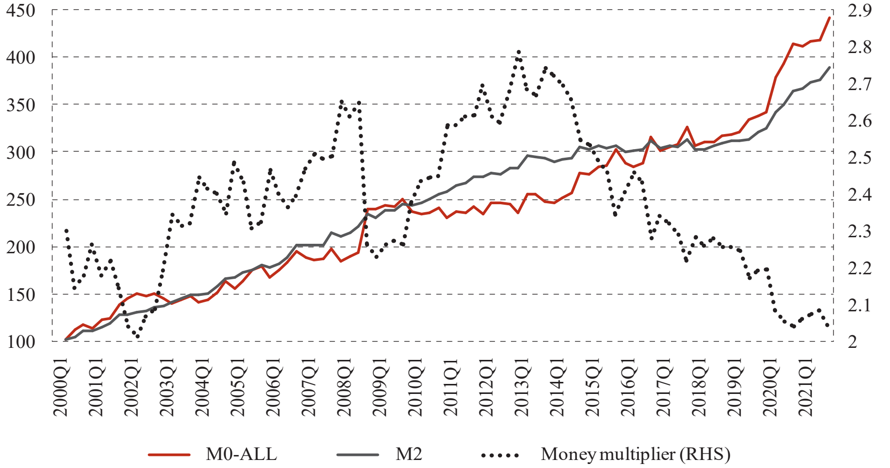
To address these concerns and shield the economy from potential foreign financial shocks, the BoA introduced three policy innovations. First, it mandated that, starting from 2017, the international reserves should cover not only current account transactions but also risks associated with foreign short-term debt and the foreign currency liabilities of the banking system. Second, in mid-2018 the BoA's Supervisory Board approved the use of interventions in the foreign exchange market to counteract the effects of lek appreciation and help achieve the price-stability objective.[6] Third, the BoA introduced a de-euroisation strategy by setting asymmetric reserve requirements on foreign (from 10 to 12.5%) and domestic currency deposits (from 7.5 to 10%).

These policy innovations, together with interest rate cuts, eventually changed the size and composition of the BoA's balance sheet and the sources of money creation in the economy. The balance-sheet expanded by 89% from the start of the GFC until end-December 2019, and by another 30% from the start of the Covid pandemic until end-December 2021.[7] This, however, did not result in a similar increase in monetary aggregate M2. Graph 1 shows that the money multiplier declined sharply after 2016. Bernanke (1995) argued that a falling money multiplier was a sign of disintermediation, indicating that banks had no interest in increasing reserves by further borrowing in weekly or longer-term repo auctions. This evidence of weak financial intermediation, together with effects of three policy innovations noted above, shifted the sources of money creation away from borrowed funds to non-borrowed or permanent monetary injections.

[5] Authors' calculations, based on Ministry of Finance (2023: 52).
[6] See BoA Supervisory Council Decision no. 49 (6 June 2018). Despite these interventions, the BoA held on to its free-floating exchange rate regime: it announced the amount and the calendar of interventions at the beginning of each year and executed them on schedule so as not to surprise the market (see Sejko, 2021; Tanku, Vika and Gjermeni, 2007; and BoA Annual Reports).
[7] While this is relatively small compared with balance sheet expansions of the Federal Reserve and the ECB, it is still significant given that the BoA decided not to implement standard quantitative easing (see Sejko, 2021).

Graph 1

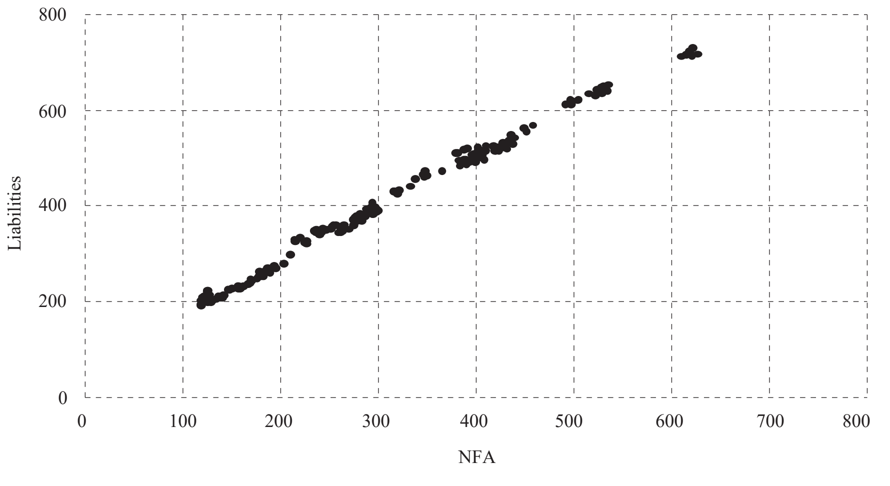
Financial intermediation and M0 money multiplier 2000 Q1=100 (in %)



Source: BoA and authors' calculations based on the BoA balance sheet data.

Graph 2

BoA liabilities and NFA, 2002-22, in billions of ALL



Source: Authors' calculations based on the BoA balance sheet data.

The identification of central bank policy actions as permanent monetary injections is widely discussed in the literature. Krugman, Dominquez and Rogoff (1998), for example, related permanent injections to purchases of assets or foreign exchange, while repurchase agreements and other open market operations that constituted borrowing at fixed-term maturity were considered temporary. Eggertson and Woodford (2003), and Buiter (2014) compared permanent monetary injections with "helicopter drops", i.e. with commitment to permanent monetary base increases.[8] Svenson (2003) expanded this notion to purchases of unlimited amounts of foreign currency in the forex market, relating permanent expansion of monetary base to a policy of currency depreciation and increases in net foreign assets (NFA) on the central bank balance sheet.

There is also a large body of literature discussing the effectiveness of permanent vs. temporary monetary injections under zero lower bound conditions or a liquidity trap scenario.[9] One finding is that permanent expansion or shocks in the monetary base can have positive impact on inflation. However, if monetary expansions were perceived as temporary, the increase in inflation would not materialise. Krugman, Dominquez and Rogoff (1998) showed that the distinction between permanent and temporary monetary injections was even clearer in a liquidity trap situation. These findings hold across a range of models, from classical and modern quantity theory of money, to new Keynesian.

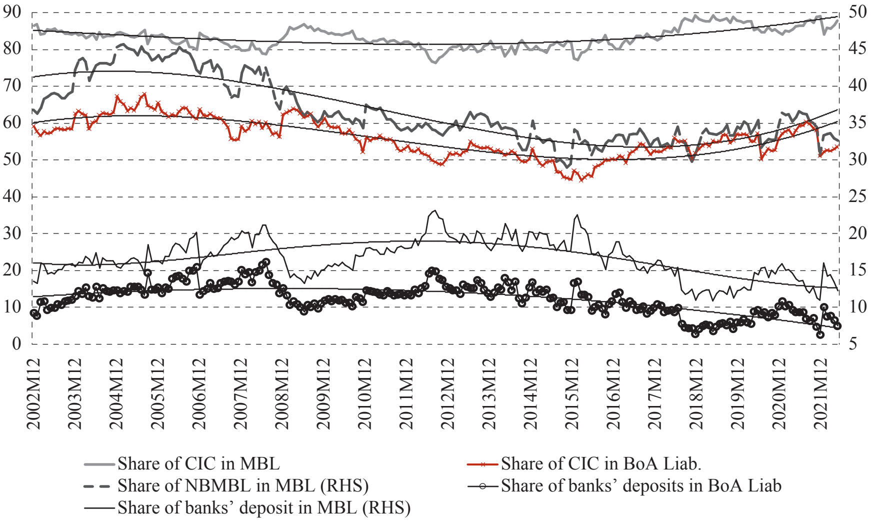
BoA's monetary statistics indicate that NFA became a significant source of base money creation and balance sheet expansion by the mid-2010s, and that increases in NFA and the size of the balance sheet were highly correlated, as shown in graph 2. Over time, these developments resulted in a change in the structure of BoA liabilities in favour of permanent or non-borrowed funds. Graph 3 shows a decrease of 10% in the share of banks' deposits on the BoA's balance sheet between end-2015 and Q1:2022, with the share of currency in circulation increasing by around 10% over the same period. The same pattern can be observed in terms of the monetary base in lek.

We investigate empirically whether changes in the structure of the monetary base can be identified as a monetary shock. To this end, we must show that the observed changes in inflation were not directly or indirectly driven by the three policy innovations undertaken by the BoA. The empirical model must account for these effects if they are present in the data. Exchange rate management in favour of the inflation objective is a good example to illustrate the issue. The direct effect of the exchange rate on inflation is accounted for by including the exchange rate in model specification. However, unsterilised purchases of foreign exchange simultaneously lead to higher NFA and the expansion of the central bank balance sheet and monetary base. Through the money multiplier, the increase in monetary aggregates could raise inflation. This effect could materialise regardless of the permanent vs. temporary nature of monetary injections.

[8] "That is … a permanent increase in the stock of base money through an irreversible open market purchase by the central bank of non-monetary sovereign debt held by the public – that is, QE" (Buiter, 2014:1).
[9] See, e.g. Beekworth (2017), and Sumner (2021).

Graph 3

Monetary indicators, as percentage of BoA liabilities and monetary base in lek (MBL)



Source: Authors' calculations based on the BoA balance sheet data.

The same could be true of policies to increase international reserves to cover short-term foreign liabilities, and to differentiate reserve requirements across foreign and domestic deposits. They are not traditional monetary policy interventions and as such should not affect inflation directly. Yet both rely on the monetary transmission mechanism, and hence their indirect effects on inflation could not be excluded. However, as we argue below, such indirect effects are unlikely under conditions prevailing in Albanian money and financial markets.

The decision to increase international reserves aims to address financial stability concerns and one can therefore exclude an intentional and direct influence of this policy on inflation. However, as with forex purchases, higher reserves increase NFA and thereby contribute to the expansion of the central bank balance sheet and monetary base, which can have an indirect effect on inflation.

Differential reserve requirements are aimed at reducing euroisation rather than affecting inflation. Nevertheless, as they are also a monetary policy instrument, changes in reserve requirements could affect inflation directly. This effect is likely to be small, however, because decreases in requirements on domestic currency deposits are offset by equivalent increases in requirements on foreign currency deposits, leaving total required reserves and M3 more or less unchanged.[10] Changes in reserve requirements have, however, two indirect effects on the Central bank balance sheet and hence potentially on inflation: they permanently release a fraction of required reserves in domestic currency, and they permanently increase NFA.

[10] Note that the lek and foreign currency deposits account for about 50% of total deposits each.

In sum, all three policy innovations have an indirect and immediate effect on M0. In normal circumstances, the increase in M0 would lead to an increase in other monetary aggregates and eventually inflation. In Albania, however, the growth rate of M2 has been lower than that of M0 since mid-2010 (graph 2).[11] This implies that BoA policy innovations could not have had the impact on money (M2) and the inflation expected under the traditional monetary transmission mechanism.

3 EMPIRICAL FRAMEWORK

Our main goal is to test whether structural changes in the central bank balance sheet described above are identified as a potential second monetary policy shock in the presence of, and in addition to, the interest rate shock. If that were the case, the evidence would provide empirical support for the hypothesis that permanent liquidity operations have positive effect on inflation in the context of a small open emerging market economy such as Albania. We test this hypothesis on a small-scale structural SVAR with identification based on Oularis, Pagan and Restrepo (2018). The methodology is relatively new and has not been previously applied in empirical studies of economies such as Albania.

3.1 EMPIRICAL MODEL

The traditional VAR(p) is represented by a system of simultaneous equations:

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + \dots + A_p z_{t-p} + \mu + \varepsilon_t \qquad (1)$$

where z_t is a vector of n endogenous variables; $A_1, \dots, A_p$ are matrices of size (n x n) of the parameters to be estimated; μ is a vector of n constants; and ε_t represents a vector of (n x 1) error terms. The VAR model of equation (1) can also be thought of as a structural vector autoregressive model (SVAR) represented:

$$Az_t = A_L + Bu_t \qquad (2)$$

where matrix A represents the structural links; A_L represents the time lag structure expressed as $A_1 z_{t-1} + \dots + A_p z_{t-p}$; and B is the matrix that defines the constraints related to the impulse response functions of the orthogonalised shocks u_t. Assuming no restrictions are imposed on the matrices Aj, for $j = 1, \dots, p$, of the A_L, SVAR takes the form:

$$A\varepsilon_t = Bu_t \;\text{ ose }\; A\varepsilon_t = B\eta_t \qquad (2.1)$$

where η_t defines the innovations that have unit variance relative to u_t, which has no unit variance.

The traditional identification schemes impose restriction on matrices A and/or B. Gali (1992) was the first to observe that the presence of cointegration constituted

[11] See Krugman, Dominquez and Rogoff (1998) for an early discussion of the breakdown in money multiplier and the inability of monetary policy to influence inflation and economic activity.

a special case of restrictions in the data generation process. Cointegration means that nonstationary time series coexist in a long-run equilibrium. This long-run equilibrium imposes limitations on the behaviour of variables and on the way shocks are transmitted within the system. Gali used this system to identify structural constraints in the SVAR long-term behaviour matrix. However, Oularis, Pagan and Restrepo (2018) showed that when cointegration was present, the correct form of the model was vector error correction (VECM) rather than VAR, so that Gali's identification method was incorrect.

The use of SVAR thus requires the conversion of the VECM to a standard VAR model. Assuming the existence of r cointegrating relationships (for $r < n$), the VECM model takes the following form:

$$\Delta\zeta_t = \alpha\beta'\zeta_{t-1} + \Phi_1\Delta\zeta_{-1} + e_t \tag{3}$$

where α and β represent matrices (n x r) describing the cointegrating relationship, i.e. the matrix of coefficients of the error term and the matrix of cointegrating vectors; ζ_{t-1} is the vector of the level of non-stationary variables in period $t – 1$; and ζ_{-1} is the vector of the first differences of z_t. Assuming that $\Phi_1 = 0$ and multiplying both sides of equation 3 with the matrix of simultaneous coefficients allow the structural form of the VECM, i.e. SVECM, to be written as follows:

$$\Phi_0\Delta\zeta_t = \alpha^*\xi_{t-1} + \varepsilon_t \tag{4}$$

where $\alpha^* = \Phi_0\,\alpha$ and $\varepsilon_t = \Phi_0\,e_t$ (Φ_0 is the same as matrix A in equation (2), while $\xi_t = \beta'\zeta_{t-1}$ represents the error correction terms in VECM. Oularis, Pagan and Restrepo (2018) split the vector ζ_t of endogenous variables z_t into vector ζ_1 ([(n-r) x 1] of variables with stochastic trends, and vector ζ_2 [rx1] of variables that experience only transitory shocks. Therefore, a model of n variables of which r are cointegrated then takes the form:

$$\Phi^0_{i1}\Delta\zeta_{1t} + \Phi^0_{i2}\Delta\zeta_{2t} = \alpha^*\xi_{t-1} + \varepsilon_{1t} \tag{5}$$

where i = *(1, 2)* represents the first and the second block of equations in SVECM (composed, respectively, of the $n – r$ variables with permanent stochastic and r cointegrating relationships); ζ_{1t} represents the vector of $n – r$ variables with permanent stochastic trends; ζ_{2t} represents the vector of r transitory shocks; and $\xi_t = \beta'_1\zeta_{1t} + \beta'_2\zeta_{2t}$. One can further eliminate transitory trends from model 5 using the cointegration relationships and the fact that equations with permanent stochastic trends have the adjustment coefficient α^* equal to 0; equation (5) can be written as:

$$A^0_{i1}\Delta\zeta_{1t} + A^0_{i2}\xi_t = A^1_{i2}\xi_{t-1} + \varepsilon_{2t} \tag{6}$$

where $A^1_{i2} = A^0_{i1}\alpha^*$ for i = *(1, 2)*, as described in equation (5). Equation (6) represents the SVAR form of the SVECM in equation (5). This SVAR consists of $n – r$

variables with permanent stochastic trends $\Delta\zeta_{1t}$ and r cointegrating relationships ξ_t, which replace r variables without stochastic trends. The matrices of coefficients A_{21}^0, A_{22}^0 *and* A_{22}^1 of the SVAR are not the original matrices Φ_j of the SVECM, however. Oularis, Pagan and Restrepo (2018) note that the shocks in the SVAR are similar to those in the SVECM, preserving their information value for empirical analysis. They show that the model can be easily extended to incorporate the presence of the stationary variables in the data generating process. In that case the SVAR would take the form:

$$A_{i1}^0 \Delta\zeta_{1t} + A_{i2}^0 \xi_{2t} + \Psi_{i3} w_t = A_{i2}^1 \xi_{t-1} + \varepsilon_{it} \tag{7}$$

where i = *(1, 2, 3)* with 1 and 2 as described above and 3 representing the block of stationary variables, and w_t representing the set of stationary variables. Equation (7) represents the functional form of our empirical model.[12]

3.2 DATA AND IDENTIFICATION OF SVAR

In selecting the variables, we follow the literature that uses a similar VAR methodology. Variables of interest are those broadly associated with monetary policy transmission and the relationship of money, exchange rates, and policy rates with the business cycle, real economic activity and inflation in Albania.[13] These include gross domestic product (GDP), consumer price index (CPI), the Albanian lek euro exchange rate (ER), monetary aggregate (M3), and the policy rate (REPO) as the main BoA monetary policy instrument. Both GDP and M3 are expressed in real terms. To test our hypothesis, we also include the balance sheet structural indicator to identify permanent vs. temporary monetary shocks (see below). This setup makes our model very similar to that of Bernanke and Mihov (1998).

Given the BoA's monetary policy framework, we frame the discussion in terms of the monetary base rather than borrowed vs. non-borrowed bank reserves, as for example in Bernanke and Mihov (1998). As our focus is on the BoA's monetary policy, we only look at the monetary base in domestic currency. We define the permanent monetary base in terms of non-borrowed funds, which we calculate as the arithmetic sum of currency outside banks and non-borrowed reserves of the banking system. The later equal the difference between total banking system reserves and borrowed reserves*,* which represent the net effect of repo, reverse repo and all other lending facilities extended in each period to all other depository corporations reported in the BoA's balance-sheet.[14]

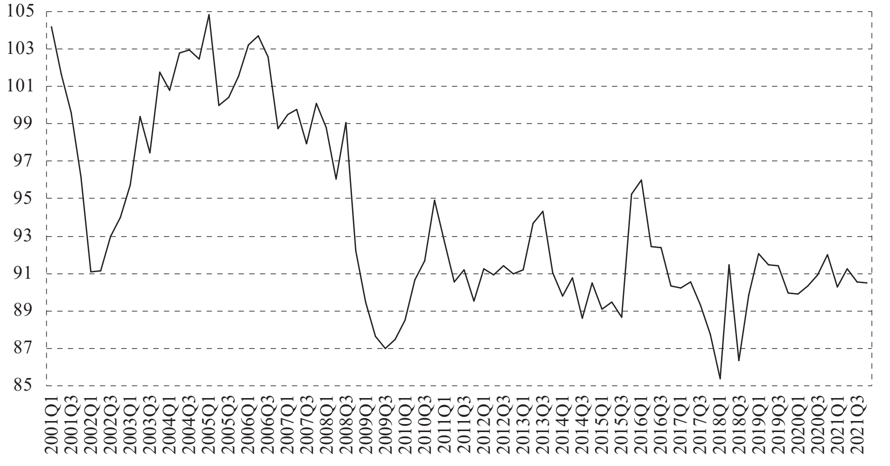
Following Bernanke and Mihov (1998), we define the balance sheet structural liquidity indicator (LI) as the ratio (in percent) of the non-borrowed monetary base to total

[12] Oularis, Pagan and Restrepo (2018) emphasise that we must specify equation (7) in terms of Δw_t if we want the shocks of stationary effects to have a permanent effect in the system.
[13] See for example Kolasi, Shijaku and Shtylla (2010), Shijaku (2016), Bahmani, Miteza and Tanku (2020), and Miteza, Tanku and Vika (2023).
[14] Calculations are based on the sectoral balance sheet data.

monetary base, both in domestic currency. The balance sheet indicator is shown in graph 4. The mean of the series differs before and after 2008, indicating a likely structural break. This is not surprising in view of the differences in monetary operations: before 2008, in an environment of abundant liquidity, BoA's open market operations were mostly repurchase agreements; following the GFC, they switched to reverse repos. Non-borrowed monetary base stayed above 90% in 2010-13 as the economy adjusted to the negative effects of the GFC and financial intermediation shifted away from foreign currency. The rise in the indicator in 2017-18 reflects the introduction of policy innovations, which lifted the indicator again to above 90%.

Graph 4

Balance sheet structural indicator



Source: Authors' calculations based on the BoA balance sheet data.

Data come from the BoA and the Albanian Institute of Statistics. Commodity prices (PCOM) are included to account for foreign price shocks; they are sourced from the IMF. We use quarterly data from Q1:2000 to Q4:2021. All series, with the exception of the policy rate, are expressed in logs and are seasonally adjusted. Seasonal adjustments, tests, and estimations are carried out in EViews. Appendix graphs A1 and A2 depict individual variables and their bilateral relationships, while table A1 provides summary statistics of variables.

Previous studies found that prices, money, GDP, exchange rate, and the policy rate in Albania were cointegrated in the long run.[15] We use this information for structural identification in our SVAR. We start with a detailed analysis of statistical properties of the dataset. Unit root and cointegration tests reveal that there are four permanent stochastic trends and only one cointegration relationship in the system (tables A2 and A3). CPI, GDP, ER, and PCOM are non-stationary in level and stationary in the first difference and are thus considered to be integrated of order 1. The balance sheet

[15] See, e.g. Shijaku (2016), Bahmani, Miteza and Tanku (2020), Miteza, Tanku and Vika (2023).

indicator is stationary before and after the structural break in Q3:2008. The policy rate is trend-stationary in level. Surprisingly, seasonally adjusted M3 is also stationary in level. Previous research found it to be a unit root process, but our test results are very robust, indicating there is no stochastic trend in M3 and, hence, no permanent influence of money on I(1) variables, including CPI. Regarding the presence of cointegration among I(1) variables, both trace and max-eigenvalue test statistics suggest the existence of one cointegrating relationship among CPI, GDP, ER and PCOM. In line with Tanku and Vika (2020), and Miteza, Tanku and Vika (2023), we decided that the CPI carried over the cointegration relationship.

Following Ouliaris, Pagan and Restrepo (2018) we proceeded with estimation using ARDL based on Pesaran, Shin and Smith (2001). The results are reported in table 1. Test statistics confirmed the existence of a cointegration relationship. The reported F statistic of the bound test is above its threshold value; in addition, the estimated coefficient on the error correction term is negative and statistically significant. On this basis, and given that our identification relies on long-run restriction methodology, we drop M3 from the model and estimate a mixed SVAR of four cointegrated I(1) and 2 stationary variables. This is helpful in view of the short time span of the dataset.

Our identification strategy requires substituting the cointegrating relationship (labelled CPI^{lr} in reported impulse response functions) for the CPI in our original VAR. With this transformation, we end up estimating the SVAR form of SVECM with three stochastic shocks (PCOM, GDP, and ER), one cointegrating relationship (standing for the CPI), and two stationary variables (the REPO and LI).

We use this information to specify the identification scheme in our structural VAR on the following assumptions:

1. The presence of cointegration means that the cointegration relation exerts no long-run influence on the other I(1) variables in the VAR;
2. I(0) variables, REPO and LI, exert no long-run influence on either I(1) or I(0) variables in SVAR;
3. Domestic variables are exogenous to PCOM, given the small size of the Albanian economy.

Table 1

Estimates of linear ARDL equation (1)

Panel B: Long-run coefficients				Panel C: Diagnostic statistics		
Constant	**LGDP_SA**	**LER_SA**	**LPCOM_SA**	**F-Bound test statistic**		**ECM**
0.59***[b]	0.18***	-0.12***	0.016**	11.23***		-0.48***
(2.27)[a]	(5.15)	(5.64)	(2.56)	I(0) at 1%	I(1)at 1%	(6.83)
				5.17	6.36	

[a] *Figures in parenthesis show the value of t statistic,* [b] ****/** indicate significance at 1% and 5% respectively.*

Source: Authors' calculations.

These assumptions impose 13 restrictions on the long-run matrix out of a total of 15 needed for identification of the system. To identify the remaining two restrictions, we rely on our knowledge of the monetary policy process and decision-making at the BoA. Monetary operations focus on keeping market rates close to the policy rate, and on keeping bank reserves consistent with the prevailing policy rate. Therefore, shocks in the balance sheet structure should not have any short-term impact on the policy rate. We thus set the corresponding coefficient in the short-run matrix of our SVAR to zero.

Similarly, in line with its free-floating regime, the BoA policy rate does not respond to exchange rate innovations. When the BoA is concerned about deviations of the exchange rate from its fundamental equilibrium, it intervenes in the foreign exchange market without adjusting the policy rate. As exchange shocks do not affect the policy rate in the short run, the corresponding coefficient in the short-run S matrix can be set at 0. The identification restrictions of our SVAR are summarised in F and S matrices in table 2.

The correct form of the SVAR requires that nonstationary variables and the corresponding error correction term, which substitutes for prices, are included in the model in their first difference (see Ouliaris, Pagan and Restrepo, 2018). The repo rate and the balance sheet liquidity indicator are stationary and may enter the model either in level or first difference, depending on whether we are interested in their permanent effects on nonstationary variables. This is certainly the case for the policy rate: we are interested in long-lasting effects of monetary policy and thus use REPO in levels. By contrast, the composition of the central bank liquidity is assumed to have no permanent impact on real GDP, CPI, the exchange rate and commodity prices, and thus enters the model in first differences.

Table 2

SVAR identification restrictions: long-run restrictions matrix F and short-run restrictions matrix S

F	ε_{PCOM}	ε_{GDP}	ε_{ER}	ε_{lr}	ε_{REPO}	ε_{LI}	S	ε_{PCOM}	ε_{GDP}	ε_{ER}	ε_{lr}	ε_{REPO}	ε_{LI}
PCOM	NA	0	0	0	0	0	PCOM	NA	NA	NA	NA	NA	NA
GDP	NA	NA	NA	0	0	0	GDP	NA	NA	NA	NA	NA	NA
ER	NA	NA	NA	0	0	0	ER	NA	NA	NA	NA	NA	NA
CPI^{lr} [a]	NA	NA	NA	NA	0	0	CPI^{lr}	NA	NA	NA	NA	NA	NA
REPO	NA	NA	NA	NA	NA	NA	REPO	NA	NA	0	NA	NA	0
LI	NA	NA	NA	NA	NA	NA	LI	NA	NA	NA	NA	NA	NA

[a] *Correct estimation of SVAR requires that CPI is substituted by the cointegration relationship, hence we added "lr" superscript to CPI (see also in footnote 17).*

4 ESTIMATION RESULTS

Graph 5 reports the results of our benchmark model including the impulse responses of variables to one standard deviation shock for each endogenous variable in the model.[16] The shocks are labelled as follows: shock (1) = commodity prices (ε_{PCOM}); shock (2) = real gross domestic product (ε_{GDP}); shock (3) = exchange rate (ε_{ER}); shock (4) = domestic prices (ε_{lr});[17] shock (5) = policy interest rate (ε_{REPO}); and shock (6) = balance sheet liquidity indicator (ε_{LI}).

Substituting the cointegrating relationship for the CPI changes the interpretation of responses of prices to shocks in other model variables. The "new" price variable represents the response of CPI in line with shocks to cointegrated variables. The IRFs in graph 5 indicate that CPI^{lr} responds to shocks in PCOM, GDP, and ER, whereas in perfect equilibrium it should not respond to these shocks. However, the slightly positive response of CPI^{lr} to a GDP shock is not statistically different from zero; the negative initial response of CPI^{lr} to a commodity price shock is consistent with price stickiness, which gradually tapers off; and the positive response to the ER shock is consistent with exchange rate overshooting, which gradually tapers off.

Importantly, we observe that shocks in policy variables REPO and in particular LI have the hypothesised negative and positive effects on CPI^{lr}, indicating that Central bank policies other than the interest rate can also affect inflation in the desired direction. The direct effect is small and short-lived, but the indirect effect of these policies via the exchange rate is twice as strong. Finally, the small positive response of CPI^{lr} to a rise in policy interest rates 2-4 quarters after the tightening is also consistent with the usual delayed response of inflation to policy rates; note also that CPI^{lr} turns positive when CPI falls.

With few exceptions, the responses of other variables are in line with standard predictions. The repo rate, for example, increases in response to shocks in commodity prices and economic activity. GDP increases marginally in response to shocks in commodity prices (as Albania is itself a commodity exporter), and initially falls but subsequently bounces back in response to exchange rate depreciation, indicating a J-curve effect. However, GDP does not react to changes in the long-run equilibrium.

The exchange rate depreciates in response to shocks in commodity prices and GDP (the latter reflecting a large share of imports in consumer demand) and appreciates when domestic prices fall below the long-run equilibrium, or the policy rate increases. However, some impulse responses are counterintuitive, for example, GDP's lack of response to deviations of prices from long-run equilibrium (shock 4), or a slight increase in GDP in response to a policy rate shock.

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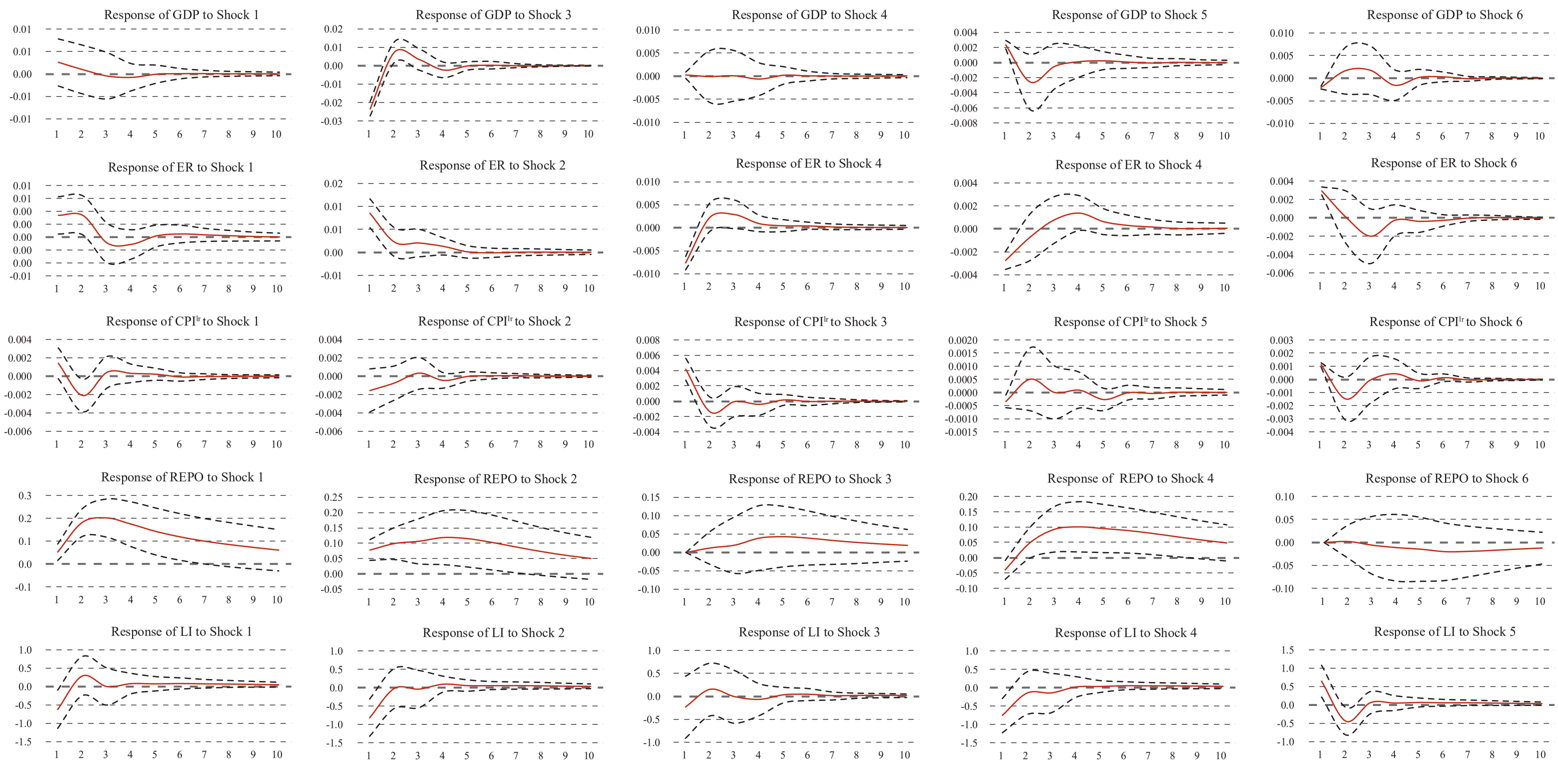
[16] Oularis, Pagan and Restrepo (2018) show that shocks in the SVAR are the same as in the original SVECM, but estimated elasticities are different. Therefore, we focus on estimated impulse response functions and do not report the coefficients.

[17] We call this shock $\mathcal{E}_{lr}$ (with *lr* standing for the long run) to highlight that it represents the cointegration relationship estimated by the ARDL method of Pesaran, Shin and Smith (2001).

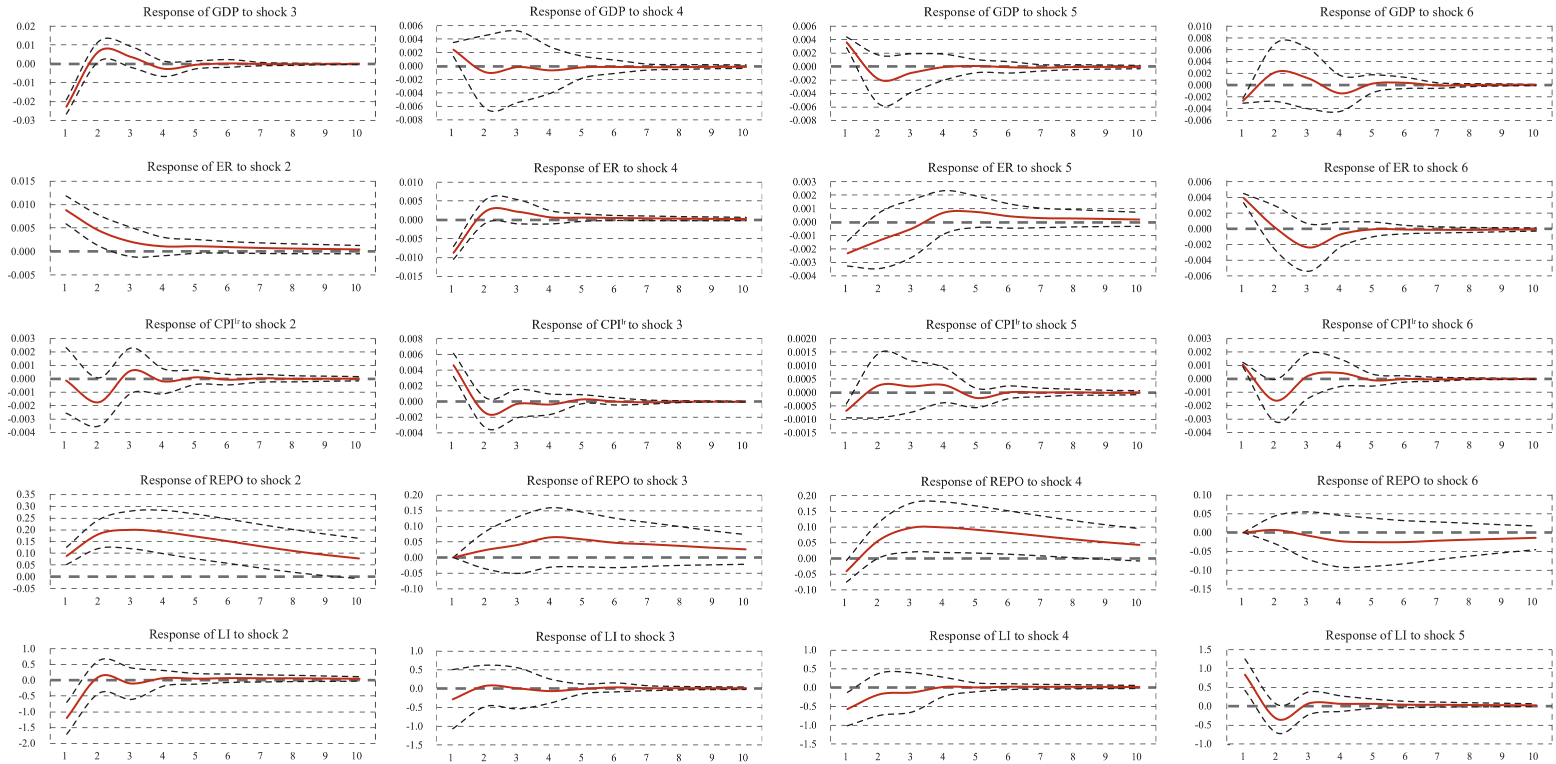
Graph 5

Response of variables to structural VAR innovations (shocks 1 – 6)



Graph 6

Response to structural VAR innovation (shocks are defined in the same way as in graph 5)

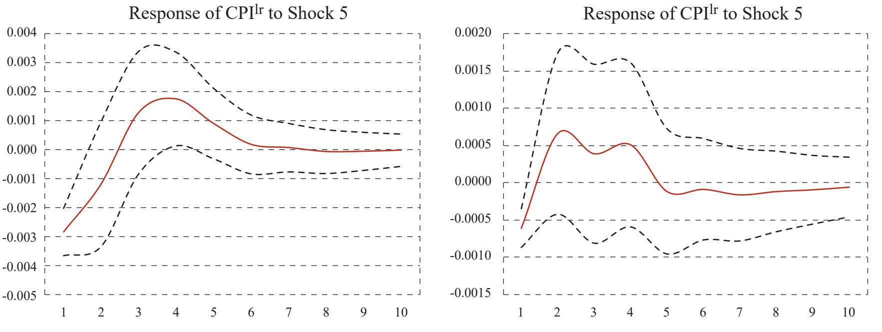


To investigate this further and as a robustness check, we estimate a nested model with foreign prices as exogenous. The results in graph 6 show that the responses of domestic prices to all shocks remain the same as in the original model. The same holds for responses of the policy variables and the exchange rate. The nested model shows the expected short-term increase in GDP when prices jump above long-run equilibrium, but the puzzling response to policy rate remains.[18]

In addition, following Gali (1992) we estimated SVAR using the *level* of cointegrating relationship. The results presented in graphs 7 and 8 show the ER and CPI^{lr} responses to REPO and LI (shocks 5 and 6, respectively). The responses are largely the same as in the original model, suggesting that monetary policy affects inflation both directly and indirectly via the exchange rate.

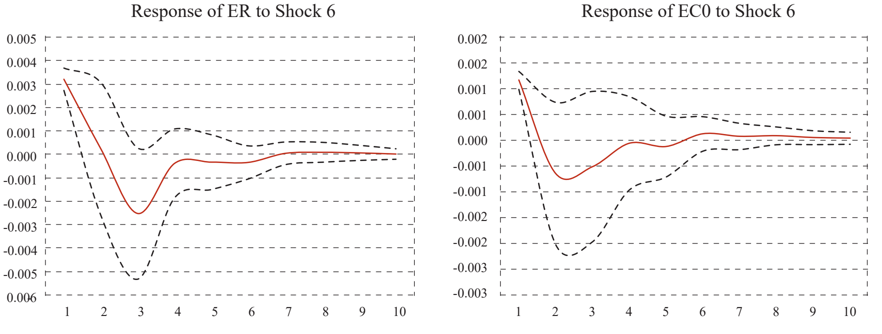
Graph 7

Response of ER to structural VAR innovations shock 5



Graph 8

Response of ER to structural VAR innovations shock 6



In sum, these findings provide support to our hypothesis that BoA policy innovations complement the policy interest rate when it falls close to zero. A cut in policy rates leads to a small increase in domestic prices and somewhat stronger exchange rate depreciation, which has a second-round effect on inflation. An additional

[18] We acknowledge that an alternative estimation approach, such as full information maximum likelihood estimator, could allow for more flexibility and precision in the specification of the correct functional form for the SVAR. However, we leave that extension for further research.

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policy shock that permanently increases the share of base money in the central bank balance sheet leads to a stronger increase in domestic prices and a larger depreciation of the exchange rate, reinforcing the impact of policy rate cuts. The responses to liquidity shocks last for two quarters and suggest the potential effectiveness of this balance sheet tool.

The muted response of M2 to changes in M0 implies that innovations by themselves did not directly affect prices through the traditional monetary transmission mechanism: the estimated effects of prices on the balance sheet structural indicator could not be driven directly by these innovations, and the estimation method ensures that the results are not driven by spurious factors.

5 SUMMARY AND CONCLUSIONS

This paper investigated the impact of changes in the liquidity composition of the BoA's balance sheet on domestic prices, and whether a shift toward permanent rather than temporary base money increases could be used as a monetary policy tool, notably when policy rates are close to zero. We constructed a balance sheet indicator that measures the share of permanent vs. temporary monetary injections in domestic currency, and tested the hypothesis that increasing the non-borrowed components of the central bank balance sheet can support the intended effects of policy rates. We tested the hypothesis by estimating an SVAR model with long-run restrictions that takes advantage of the vector error correction structure embodied in the data-generating process. Our VAR contains GDP, CPI, exchange rate, policy rate, balance sheet liquidity, and commodity prices, which enter the model as exogenous variables. The presence of cointegration in the data-generating process is the main source of identification in SVAR.

Our findings indicate that changing the structure of BoA liabilities in favour of permanent monetary injections enhances the effectiveness of interest rate policy and could give the BoA a better control of inflation. The supportive role of balance sheet policies would be particularly important in periods of financial stress or when the policy rate is close zero. Permanent monetary expansion affects prices through direct and indirect channels, notably the exchange rate. This suggests that persistent trends in the exchange rate, as well as shocks in the exchange rate that are driven by exogenous factors and are not aligned with fundamentals, should be considered in the policy context. Overall, these findings support the BoA policy stance, notably recent policy innovations with respect to the level of international reserves, the use of exchange rate interventions for policy purposes, and the use of differential reserve requirements as part of a de-euroisation strategy.

Disclosure statement
Authors have no conflict of interest to declare.

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APPENDIX

Table A1
Summary statistics

	CPI	M3	ER	GDP	REPO	LI	PCOM
Mean	83.03	906,759.2	131.35	298,645.3	4.30	93.95	118.40
Maximum	103.07	1,582.310	141.75	429,309.3	13.18	106.66	189.51
Minimum	59.79	289,340.6	121.55	143,213.3	0.50	85.39	48.82
Std. dev.	12.52	371,910.3	7.03	69,616.80	2.70	5.08	40.02
Skewness	-0.137	-0.18	-0.01	-0.28	0.40	0.67	0.05
Kurtosis	1.75	1.70	1.35	2.18	3.07	2.46	2.04
Observations	88	88	88	88	88	88	88

Table A2
Augmented Dickey-Fuller test results

		CPI	PCOM	GDP	ER	M3	REPO	LI[a]
Constant	Level	-2.117	-1.822	-2.089	-1.554	-3.786***	-1.937	-2.212
	First difference	-12.31***	-5.97***	-11.38***	-6.69***	-2.887	-5.152***	-3.24**
Constant and trend	Level	-1.833	-2.15	-2.475	-1.523	-1.527	-5.597***	-10.209***
	First difference	-13.06***	-5.94***	-11.61***	-6.68***	-8.475***	-5.074***	-10.159***

****/** indicate significance at 1% and 5%, respectively.*

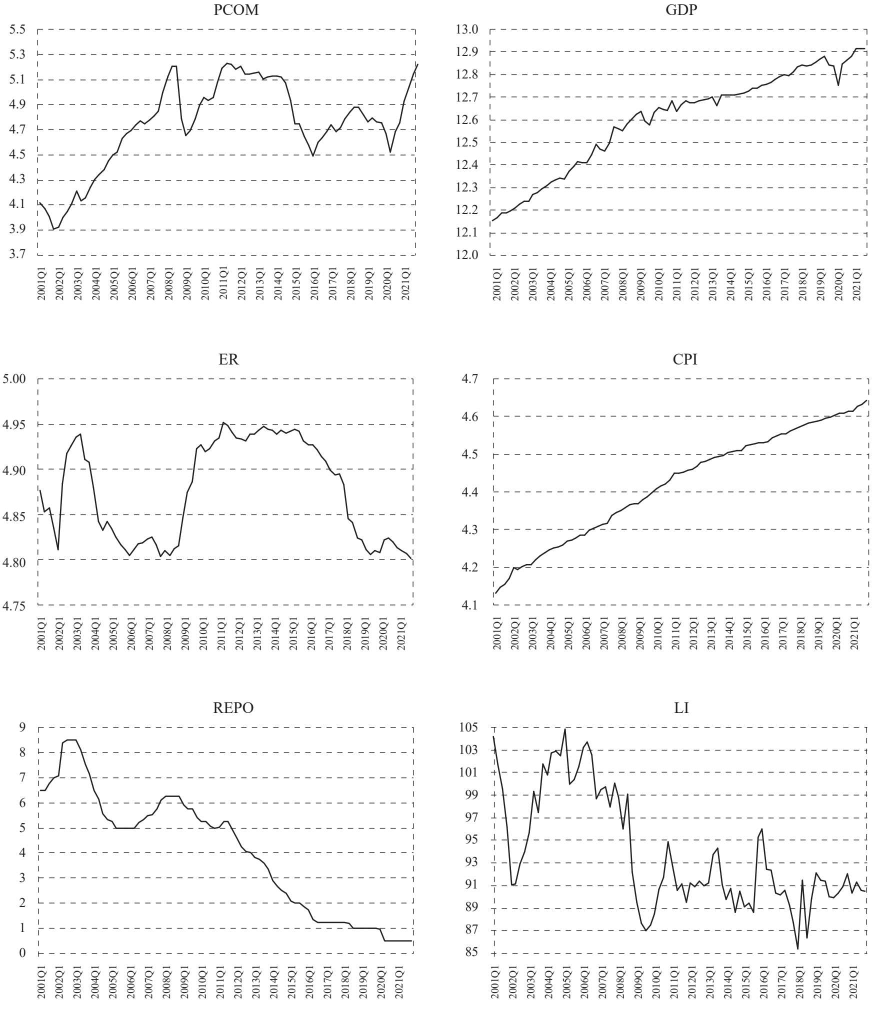
[a] *LI_SA turned out to be break-point stationary, with a structural break identified in 2008:Q3.*

Table A3
Johansen cointegration test results

Sample: 2000Q1 2022Q1					
Included observations: 85					
Series: LGDP_SA LCPI_SA LER_SA LPCOM_SA					
Lags interval: 1 to 2					
Selected (0.05 level[a]) number of cointegrating relations by model					
Data trend:	None	None	Linear	Linear	Quadratic
Test type	No intercept	Intercept	Intercept	Intercept	Intercept
	No trend	No trend	No trend	Trend	Trend
Trace	1	1	1	1	1
Max-Eig	1	1	0	1	1

[a] *Critical values based on MacKinnon-Haug-Michelis (1999).*

Graph A1
Time series of individual variables



Source: Authors' calculations.

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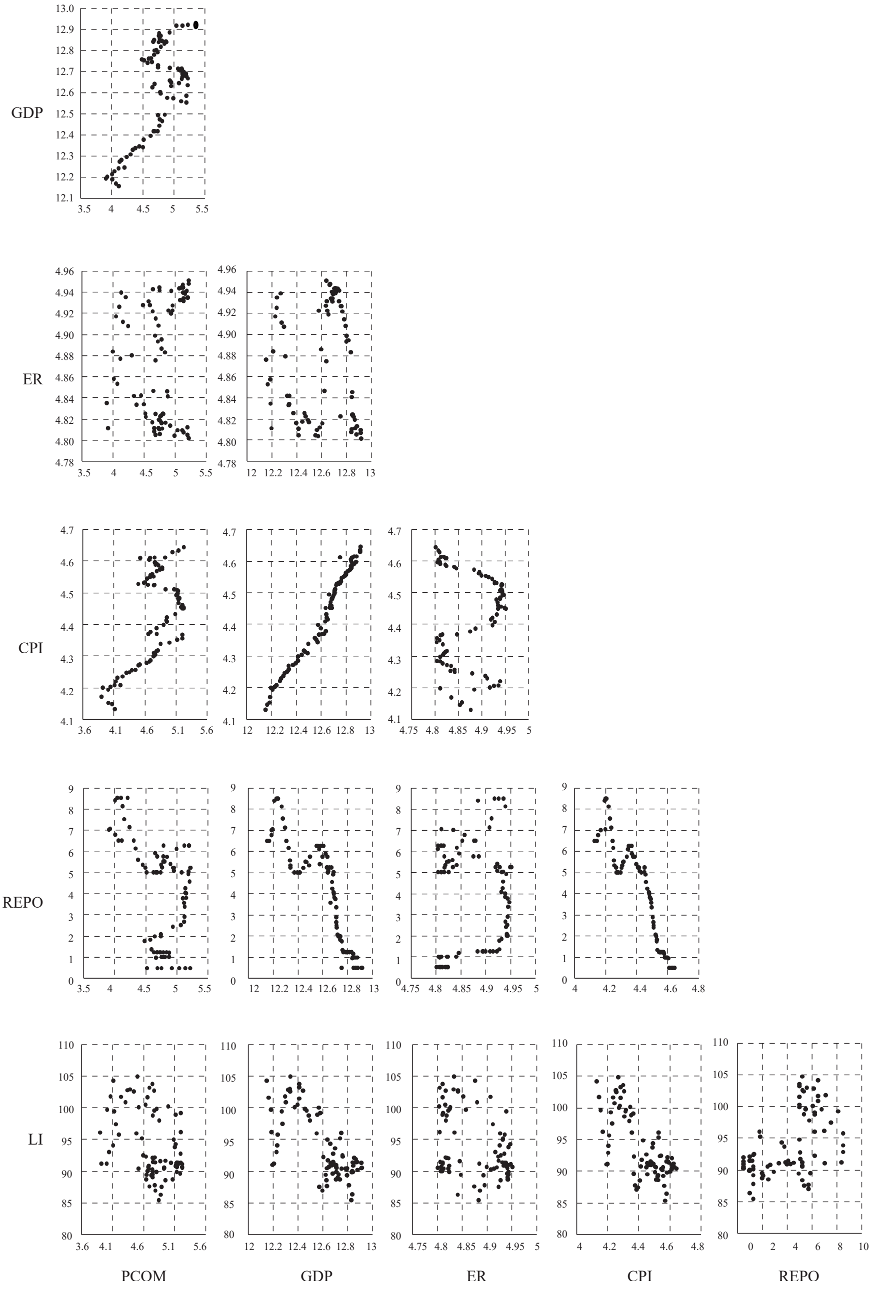
Graph A2

Scattered diagrams portraying first degree of autocorrelation and bilateral relationships



Source: Authors' calculations.